

CLAIMS

What is claimed is:

1. A filter assembly, comprising:

a first housing;

5 a second housing at least partially disposed within said first housing, wherein said second housing comprises a first flow path; and

a MEMS filter element mounted to said second housing such that all flow through said first flow path is directed through said MEMS filter element.

2. A filter assembly, as claimed in Claim 1, wherein:

10 said first housing is selected from the group consisting of a rigid body, a deformable body, or a combination thereof.

3. A filter assembly, as claimed in Claim 1, wherein:

said first housing comprises first and second ends, as well as an opening extending between said first and second ends, wherein said second housing is disposed within said opening.

15 4. A filter assembly, as claimed in Claim 1, wherein:

said second housing is rigid.

5. A filter assembly, as claimed in Claim 1, wherein:

second housing is formed from a material selected from the group consisting of polymethylmethacrylate, titanium, implantable metals, and implantable plastics.

20 6. A filter assembly, as claimed in Claim 1, wherein:

said second housing comprises a cylindrical outer sidewall.

7. A filter assembly, as claimed in Claim 1, wherein:

said MEMS filter element is recessed within said second housing.

8. A filter assembly, as claimed in Claim 1, wherein:

said second housing comprises first and second ends, wherein said first flow path extends between said first and second ends, and wherein said MEMS filter element is disposed somewhere between said first and second ends within said second housing.

5 9. A filter assembly, as claimed in Claim 1, wherein:

said second housing comprises first and second ends, wherein said first flow path extends between said first and second ends, and wherein said MEMS filter element is disposed on said first end of said second housing.

10 10. A filter assembly, as claimed in Claim 9, further comprising:

a third housing at least partially disposed within said first housing, wherein said third housing comprises a second flow path, wherein said MEMS filter element is sandwiched between said second and third housings, and thereby between said first and second flow paths.

11. A filter assembly, as claimed in Claim 1, wherein:

15 said MEMS filter element is maintained in a fixed position relative to said second housing.

12. A filter assembly, as claimed in Claim 1, wherein:

said MEMS filter element is bonded to said second housing.

13. A filter assembly, as claimed in Claim 1, wherein:

said filter assembly is in an implant.

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14. A MEMS flow module, comprising:

a first flow port; and

a tuning element movable along an axis that corresponds with a direction of a flow entering said MEMS flow module through said first flow port, wherein a position of said tuning element is dependent upon a pressure being exerted on said tuning element by said flow entering said MEMS flow module through said first flow port, and wherein a flow rate of said flow exiting said MEMS flow module is dependent upon a position of said tuning element.

15. A MEMS flow module, as claimed in Claim 14, further comprising:

a first plate, wherein said first plate comprises said first flow port.

16. A MEMS flow module, as claimed in Claim 15, wherein:

said first plate is parallel with a surface of said tuning element that faces away from said first plate.

17. A MEMS flow module, as claimed in Claim 15, wherein:

said tuning element is always disposed in spaced relation to said first plate.

18. A MEMS flow module, as claimed in Claim 15, further comprising:

at least one spring movably interconnecting said tuning element with said first plate.

19. A MEMS flow module, as claimed in Claim 15, further comprising:

a plurality of springs movably interconnecting said tuning element with said first plate.

20. A MEMS flow module, as claimed in Claim 15, further comprising:

a first flow channel defined by a space between said tuning element and said first plate, wherein at least a portion of said flow entering said MEMS flow module through said first flow port passes through said first flow channel before exiting said MEMS flow module.

21. A MEMS flow module, as claimed in Claim 15, wherein:

during any movement of said tuning element relative to said first plate, a distance between said tuning element and said first plate is proportional across an entire extent of said tuning element.

5 22. A MEMS flow module, as claimed in Claim 14, further comprising:

a first plate that comprises a first group of a plurality of said first flow ports, wherein said tuning element is aligned with each said first flow port in said first group.

23. A MEMS flow module, as claimed in Claim 22, wherein:

all flow through any of said first flow ports in said first group is required to proceed
10 around a perimeter of said tuning element.

24. A MEMS flow module, as claimed in Claim 22, wherein:

said tuning element comprises a plurality of tuning element flow ports, wherein said plurality of first flow ports in said first group and said plurality of tuning element flow ports are arranged such that a flow through any given said first flow port must change direction to flow
15 through any of said plurality tuning element flow ports.

25. A MEMS flow module, as claimed in Claim 14, wherein:

said tuning element is disposed to change a direction of said flow entering said MEMS flow module through said first flow port before said flow exits said MEMS flow module.

26. A MEMS flow module, as claimed in Claim 14, wherein:

20 said flow entering said MEMS flow module exerts a normal force on said tuning element.

27. A MEMS flow module, as claimed in Claim 14, further comprising:

means for limiting a maximum amount of movement of said tuning element away from said first flow port.

28. A MEMS flow module, as claimed in Claim 14, wherein:
said MEMS flow module is a passive device.

29. A MEMS flow module, as claimed in Claim 14, further comprising:
a first plate; and
5 at least one spring movably interconnecting said tuning element and said first plate.

30. A MEMS flow module, as claimed in Claim 14, further comprising:
a first plate comprising a plurality of said first flow ports;
a plurality of said tuning elements, wherein at least one said first flow port is associated
with each said tuning element; and
10 at least one spring separately interconnecting each said tuning element with said first
plate.

31. A MEMS module, as claimed in Claim 14, further comprising:
a first plate comprising said first flow port;
at least one spring movably interconnecting said tuning element and said first plate;
15 a second plate comprising a second flow port and that is spaced from said tuning element,
wherein said tuning element is located between said first and second plates, and wherein at least
a portion of said flow that enters said MEMS flow module through said first flow port exits said
MEMS flow module through said second flow port; and
an annular support interconnecting said first and second plates, wherein said first plate,
20 said second plate, and said annular support collectively define an enclosed space.

32. A MEMS flow module, as claimed in Claim 31, wherein:
said second plate comprises at least one overpressure stop aligned with said tuning
element.

33. A MEMS flow module, comprising:

a first flow port;

a movable tuning element, wherein a position of said tuning element within said MEMS flow module is dependent upon a pressure being exerted on said tuning element by a flow entering said MEMS flow module through said first flow port, wherein a flow rate of said flow exiting said MEMS flow module is dependent upon a position of said tuning element within said MEMS flow module, and wherein said tuning element changes a direction of said flow entering said MEMS flow module through said first flow port before said flow exits said MEMS flow module.

34. A MEMS flow module, as claimed in Claim 33, further comprising:

a first plate, wherein said first plate comprises said first flow port.

35. A MEMS flow module, as claimed in Claim 34, wherein:

said first plate is parallel with a surface of said tuning element that faces away from said first plate.

36. A MEMS flow module, as claimed in Claim 34, wherein:

said tuning element is always disposed in spaced relation to said first plate.

37. A MEMS flow module, as claimed in Claim 34, further comprising:

at least one spring movably interconnecting said tuning element with said first plate.

38. A MEMS flow module, as claimed in Claim 34, further comprising:

a plurality of springs movably interconnecting said tuning element with said first plate.

39. A MEMS flow module, as claimed in Claim 34, further comprising:

a first flow channel defined by a space between said tuning element and said first plate, wherein at least a portion of said flow entering said MEMS flow module through said first flow port flow passes through said first flow channel before exiting said MEMS flow module.

40. A MEMS flow module, as claimed in Claim 33, further comprising:

a first plate that comprises a first group of a plurality of said first flow ports, wherein said tuning element is aligned with each said first flow port in said first group.

41. A MEMS flow module, as claimed in Claim 40, wherein:

all flow through any of said first flow ports in said first group is required to proceed around a perimeter of said tuning element.

42. A MEMS flow module, as claimed in Claim 40, wherein:

said tuning element comprises a plurality of tuning element flow ports, wherein said plurality of first flow ports in said first group and said plurality of tuning element flow ports are arranged such that a flow through any given said first flow port must change direction to flow through any of said plurality of tuning element flow ports.

43. A MEMS flow module, as claimed in Claim 33, wherein:

said tuning element is movable along an axis that corresponds with a direction of said flow entering said MEMS flow module through said first flow port.

44. A MEMS flow module, as claimed in Claim 43, wherein:

during any movement of said tuning element relative to said first plate, a distance between said tuning element and said first plate is proportional across an entire extent of said tuning element.

45. A MEMS flow module, as claimed in Claim 33, wherein:

said flow entering said MEMS flow module exerts a normal force on said tuning element.

46. A MEMS flow module, as claimed in Claim 33, further comprising:

means for limiting a maximum amount of movement of said tuning element away from

5 said first flow port.

47. A MEMS flow module, as claimed in Claim 33, wherein:

said MEMS flow module is a passive device.

48. A MEMS flow module, as claimed in Claim 33, further comprising:

a first plate; and

10 at least one spring movably interconnecting said tuning element and said first plate.

49. A MEMS flow module, as claimed in Claim 33, further comprising:

a first plate comprising a plurality of said first flow ports;

a plurality of said tuning elements, wherein at least one said first flow port is associated
with each said tuning element; and

15 at least one spring separately interconnecting each said tuning element with said first
plate.

50. A MEMS module, as claimed in Claim 33, further comprising:

a first plate comprising said first flow port;

at least one spring movably interconnecting said tuning element and said first plate;

a second plate comprising a second flow port and that is spaced from said tuning element,

5 wherein said tuning element is located between said first and second plates, and wherein at least a portion of said flow that enters said MEMS flow module through said first flow port exits said MEMS flow module through said second flow port; and

an annular support interconnecting said first and second plates, wherein said first plate, said second plate, and said annular support collectively define an enclosed space.

10 51. A MEMS flow module, as claimed in Claim 50, wherein:

said second plate comprises at least one overpressure stop aligned with said tuning element.

52. A MEMS flow module, comprising:

a housing comprising an at least substantially enclosed space, a first flow port, and a second flow port;

a first flow path through said housing, wherein said first and second flow ports are fluidly
5 connected by said first flow path; and

a tuning element disposed within said enclosed space and movably interconnected with said housing, wherein a spacing between said tuning element and a portion of said housing defines a first flow channel of said first flow path, wherein a volume of said first flow channel is dependent upon a pressure being exerted on said tuning element by a flow entering said housing
10 through said first port, wherein a flow rate of said flow exiting said enclosed space through said second port is dependent upon a position of said tuning element within said housing.

53. A MEMS flow module, comprising:

a first plate comprising a first flow port;

a tuning element movably suspended beyond said first plate and in overlying relation to said first flow port, wherein a spacing between said tuning element and said first plate defines a first flow channel, wherein a flow entering said MEMS flow module through said first flow port is forced by said tuning element to proceed through said first flow channel, and wherein a magnitude of said spacing between said tuning element and said first plate is variable and dependent upon a pressure being exerted on said tuning element by said flow entering said MEMS flow module through first flow port.

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54. A method for regulating a fluidic output from a first source, comprising the steps of:

directing a fluid from said first source through a MEMS flow module and to a second source;

5 regulating a pressure of first source during said directing step, wherein said regulating step comprises providing greater than a proportional increase in a flow rate out of said MEMS flow module for an increase in a differential pressure across said MEMS flow module; and

filtering a continually open flow path through said MEMS flow module that is fluidly connected with said first source, wherein said filtering step comprises retaining a constituent
10 within said MEMS flow module that enters said MEMS flow module from said second source, that is of at least a first size, and that is attempting to proceed along said flow path through said MEMS flow module and back to said first source.

55. A method, as claimed in Claim 54, wherein:

said first source is selected from the group consisting of an anterior chamber of a human
15 eye, a cranial reservoir, and a drug reservoir, and wherein said second source comprises the environment.

56. A method, as claimed in Claim 54, wherein:

said first source is selected from the group consisting of a man-made reservoir and a biological reservoir.

20 57. A method, as claimed in Claim 54, wherein:

said MEMS flow module comprises a tuning element for said regulating step.

58. A method, as claimed in Claim 57, wherein:

said regulating step comprises changing a position of said tuning element within said MEMS flow module.

59. A method, as claimed in Claim 57, further comprising step of:

5 positioning said tuning element such that said flow entering said MEMS flow module exerts an orthogonal force on said tuning element.

60. A method, as claimed in Claim 57, wherein:

said regulating step comprises moving said tuning element along an axis that corresponds a direction in which said flow is directed into said MEMS flow module.